GUIDANCE DOCUMENT

CANADA PLASTICS PACT

Pathways to Mono-Material Flexible Plastic Packaging

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Contents

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About this Guide

This guidance document has been developed by the Canada Plastics Pact (CPP) as a tool to support internal and external engagement in line with efforts to improve the recyclability of flexible plastic packaging and films in Canada.

The *Pathways to Mono-material Guide* is a supplement to CPP's Flexibles Roadmap. The purpose of the Guide is to provide practical information and guidance on the design and manufacturing pathways that enable moving from complex, multi-material flexible plastic packaging to more recyclable mono-material polyethylene (PE) or polypropylene (PP) flexible packaging, where and when it makes sense (i.e., without compromising the functionality or performance of the package).[1] Moving to more mono-material flexible packaging enables the likelihood for increased collection, sortation, and effective mechanical recycling of flexible plastic packaging at scale, with less contaminated/mixed material streams, while avoiding product waste and pollution—thereby advancing the circularity of flexible plastics.

This guidance has been developed in line with the Golden Design Rules (GDRs) for Plastics Packaging, in particular GDR 6 (i.e., to increase the recycling value of flexible consumer packaging), and the Association of Plastic Recyclers' (APR) Design® Guide for PE and PP film packaging. More information on both can be found in this document. More information on the GDRs can be found in this document.

Note: While outside of scope for this guidance document, retailers, brand owners, producers, and manufacturers should consider the options and impacts (e.g., GHG emissions, recyclability) of all their packaging formats and materials, including consideration for reusable/refillable packaging systems.

[1] Note the preference in the Canadian market at present is for mono-polyethylene over mono-polypropylene given existing recycling infrastructure.

Targeted Audiences

This guidance document has been developed with packaging manufacturers, producers, brand owners, and their packaging design engineers and marketing departments in mind. Additional audiences that may find this guidance useful include converters, recyclers, and governments, and other stakeholders involved in the plastic packaging and recycling value chain.

Technical Guidance

A Supplementary Technical Guidance document was developed to support the recyclability of flexible plastic packaging in Canada. It highlights viable mono-material PE and PP solutions informed by 2024 technical workshops co-hosted by the U.S. and Canada Plastics Pacts. This document is available exclusively to CPP Partners and U.S. Plastics Pact Activators; request access at info@plasticspact.ca.

Benefits to Users

- ✔ Provides guidance on what to consider when evaluating converting a multi-material flexible plastic packaging structure to a mono-material structure.
- ✔ Identifies the pathways for moving to mono-material flexible plastic packaging, as well as key considerations and potential challenges.
- ✔ Identifies the key polymers and its properties, and which ones are most compatible for mechanical recycling.
- ✔ Provides examples of mono-material structures designed for recycling.
- ✔ Provides additional resources and supporting information for users.

Abbreviations

AlOx	Aluminum oxide
BOPE	Biaxially oriented polyethylene
CPP	Cast polypropylene
EAA	Ethylene acrylic acid
EMAA	Ethylene methacrylic acid
EVA	Ethylene vinyl acetate
EVOH	Ethylene vinyl alcohol
HDPE	High density polyethylene
LDPE	Low density polyethylene
LLDPE	Linear low-density polyethylene
Met	Metallization coating

MDO-PE	Machine direction orientation polyethylene
OPP	Oriented polypropylene
PA	Polyamide (Nylon)
PE	Polyethylene
PET	Polyethylene terephthalate
PO	Polyolefins
PP	Polypropylene
PVC	Polyvinyl chloride
PVDC	Polyvinylidene chloride
PVOH	Polyvinyl alcohol
SiOx	Silicon oxide

Golden Design Rules (GDRs)

The Golden Design Rules (GDRs) for Plastics Packaging, developed by The Consumer Goods Forum's Plastic Waste Coalition of Action, are voluntary, independent, and time-bound commitments, that outline specific design changes for plastic packaging, aligned with globally recognized technical guidelines and the targets laid out in the Ellen MacArthur Foundation's (EMF) New Plastics Economy Global Commitment.

The Pathways to Mono-material Flexible Plastic Packaging Guide is aligned with the GDRs, in particular the Canadian Guidance for GDR 6, to increase the recycling value of flexible consumer packaging.

The GDRs aim to change how packaging is designed in the first place to keep it in the economy and out of the environment. The nine GDRs provide a clear framework that aims to drive innovation and scalable actions that will result in less plastic packaging overall and easier to recycle plastic packaging by 2025.

The implementation of the Golden Design Rules in Canada is being led by the Canada Plastics Pact. which is part of the EMF's Global Plastics Pact Network. The CPP is focused on advancing a circular economy for plastic packaging in Canada, adopting a full value chain approach to supporting the transition.

GDR #6

Increase Recycling Value in Flexible Consumer Packaging

Canadian GDR 6

- Design choices should strongly preference **mono-PE or mono-PP*** in the Canadian market (rather than multi-material or mixed poly-olefin content): **Minimum >90% mono PE or >90% mono PP.**
- Only use barriers and additives in accordance with APR Design Guidelines for **PE and PP films, to a maximum of 10% barrier layer (which can be only one layer).**
- This rule states that for a packaging types where there is not a clear pathway to a recycling system by 2025, this rule is not required to be followed--there may be limited instances where this is the case in Canada (e.g., PET top lidding). However, this should not limit R&D in packaging alternatives, nor the development of advanced recycling technologies. The CPP commits to revisiting the technology landscape and updating this guidance accordingly.

* **Note:** More technical, standardized definitions for PE (such as HDPE, LDPE, LLDPE, MDPE, VLDPE) and PP resins can be found described in ASTM D4976 and ISO 19069, respectively.

What is Flexible Packaging?

Flexible packaging is a package or container made of flexible or easily yielding materials that, when filled or closed, can be readily changed in shape.

They are used for consumer and institutional products, as well as in industrial applications, to protect, market, and distribute a vast array of products. Flexible packaging typically takes the shape of a bag, film, lidding, liner, overwrap, pouch, roll stock, sleeve, or wrap (Flexible Packaging Association).

Flexible packaging can be used for a wide variety of applications, including fresh and frozen goods, lawn and garden products, dry goods, medical products, and liquid products. It can even be used in microwave applications if the polymer structure is appropriate.

The use of flexible plastic packaging as the predominate packaging type has grown significantly over the last couple of decades. This packaging is well recognized and known for its lightweight, durability, versatility, low cost, superior functionality, efficient extension of food shelf-life, and resource efficiency – thereby offering sustainable advantages.

There are two types of flexible plastic packaging: **multi-material structures and mono-material structures**.

Types of Flexible Packaging

Multi-material flexible plastic packaging

Multi-material flexible plastic packaging contains more than one layer of material, where no single material type typically exceeds 90% of the total structure. In other words, where the minority fraction of any additional resin is no more than 10%. The combination of several layers and coatings of different materials improves the mechanical and physical properties of the package/film including puncture, tear, and heat resistance as well as moisture and oxygen barrier properties.

Multi-material flexible packaging, films, and pouches are often used for food products (such as cheese, fresh meat, or nuts), which are designed for specific performance requirements such as gas barrier protection, as well as preventing moisture and contaminants from penetrating the packaging. This includes polymers/copolymers such as PE, PP, Nylon (PA), PET, and others, and may also include coatings such as PVDC, SiOx, AlOx, metalized films and non-polymeric layers, such as aluminum foil. See Appendix A: Polymers, Barriers & Properties. While this type of packaging offers great value of extending shelf-life of foods during its use phase, it tends to be difficult to mechanically recycle in post-use phase.

Based on growing concerns to make plastics more circular, there are increasing demands to convert multi-material flexible plastic packaging to mono-material flexible plastic structures, whenever possible. With continued advancements in research and development (R&D) to make mono-material flexible packaging meet the high barrier and shelf-life performance requirements for food packaging, this option is an increasingly viable alternative to the difficult to recycle multi-material structures.

Mono-material flexible plastic packaging

Mono-material flexible plastic packaging structures contain predominantly one material type, such as either PE (LDPE, LLDPE, HDPE), or PP. Bi-axially oriented and non-oriented forms of the same base polymer (i.e., either PE or PP) are considered to be mono-materials. Although preference is for mono-material packages to be made from a single base polymer only (i.e., PE), to obtain certain performance requirements this may not be possible. Some polymers, such as EVOH and nylon, may be considered to have a neutral effect on the recycling stream when combined with PE at recommended levels, as defined with the GDRs and the Association of Plastic Recyclers' (APR) Design Guide.[2]

It is worth noting that mono-material does not necessarily mean mono-layer. Researchers are working to expand the solutions that bring the benefits of multi-material, multi-layer structures to mono-material packaging. Such solutions are now available in the form of mono-material, multi-layer structures.

[2] RecyClass design for recyclability guidance notes that the presence of nylon produces a "conditional – limited compatibility" if <15% PA 6/66 copolymer with melting temperature < 192 ∘C and incorporating >= 10% PE-g-MAH tie layers when used as a barrier layer and a "No – low compatibility" for any other PA barriers.

Common Flexible Plastic Packaging

Mono-Materials

- Produce bags
- Bread bags
- Air pillows
- Food storage bags
- Frozen food bags
- Stretch wrap
- Paper towel packages
- Dry grocery bags
- Dry cleaner bags
- Newspaper bags
- Bubble wrap
- Party supply packs
- Toilet paper wrap
- Home & garden bags

Multi-Materials

- Plastic shipping envelopes
- Frozen food pouches
- Meat, cheese & fish wraps
- Baby food packages
- Arts & crafts packages
- Plastic wrap
- Salad bags
- Six-pack rings
- Pet food bags
- Pharmaceutical wraps
- Wipes packages

Why Use Flexible Packaging?

Where single-use packaging cannot be avoided, flexible packaging is an ideal choice for many products given its benefits (e.g., carbon footprint benefits during transportation).

Life cycle analyses (LCAs) have shown that flexible packaging has the smallest carbon footprint compared to other single-use packaging formats, especially for food applications.

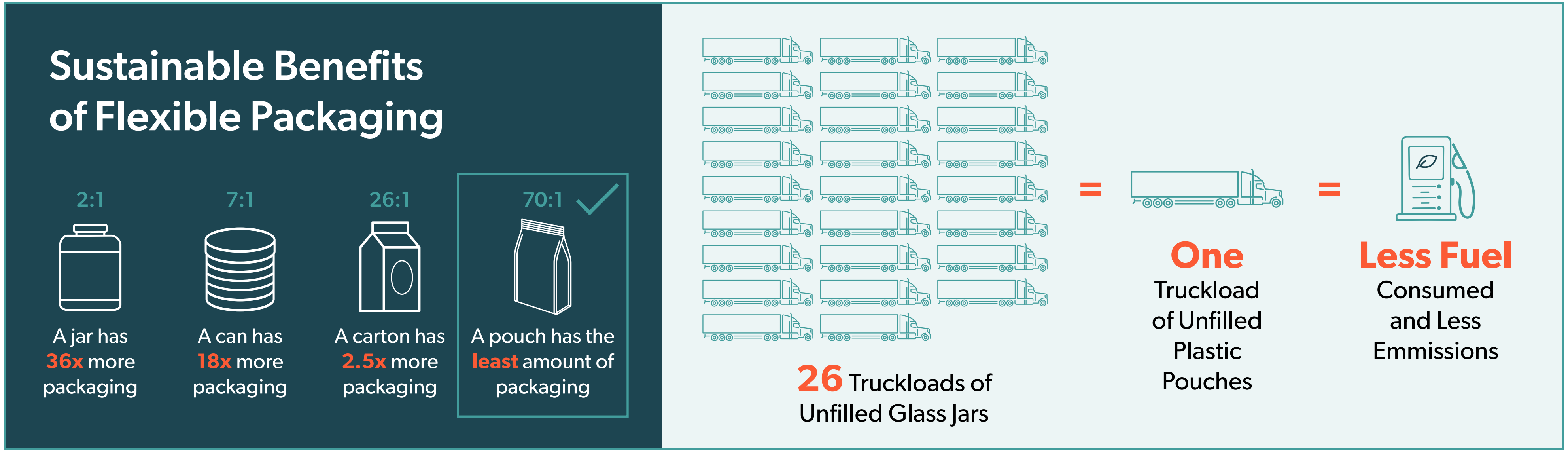
Note: the analysis shown is based on a single use for each packaging type, and does not include a comparison with reusable packaging, or for considerations for if the packaging format is recyclable or not.

Coffee Packaging Case Study - LCA

Although the flexible SUP is not mechanically recycled at post use, it has more favourable environmental outcomes versus rigid plastic canister and metal can.

Format	Fossil Fuel Consumption (Mj-Eq.)	Ghg Emissions (Kg-Co2 Eq.)	Water Consumption (L)	Product-To-Package Wgt. Ratio (%)	Pkg Landfilled (G/1000 Kg Coffee)
Stand-Up Flexible Pouch	6,654	353	1011	96 : 4	40,294
Plastic (HDPE) Canister	41,130 (+518%)	1,678 (+376%)	3,164 (+213%)	83 : 17	142,063 (+252%)
Steel Can	36,809 (+453%)	2,763 (+683%)	17,238 (+1605%)	67 : 33	163,122 (304%)

Source: Flexible Packaging Association (FPA) study conducted by PTIS (www.ptisglobal.com) using EcoImpact-COMPASS LCA tool. See FPA's 'A Holistic View of the Role of Flexible Packaging in a Sustainable World", pages 129-135.



While alternative material packages provide value in certain applications, flexible plastic packaging delivers multiple sustainability benefits when evaluated across the whole life cycle in many cases, despite not typically being recycled post-use in Canada today (especially multi-material structures). These benefits include that it:

- ✔ provides a high product-to-packaging ratio;
- ✔ does not dent or shatter when dropped;
- ✔ is lighter weight than rigids (e.g., jars, cans, bottles);
- ✔ can reduce GHG emissions over heavier packaging materials and formats due to space savings granted during transport of flexible packaging (e.g., one truckload of product in flexible packaging accomplishes the same as 26 truckloads of rigid containers);
- ✔ has an ability to transport a substantial amount more of empty flexible packaging than what is possible with rigid packaging;
- ✔ requires less energy and water to produce flexible packaging than some other types of packaging materials and formats, therefore creates fewer GHG emissions; and,
- ✔ can have its labeling information printed directly on the package as opposed to having an adhesive label added which may contaminate the recyclability of the packaging.

Moving to Mono-material Packaging Structures

Mono-material packaging offers significant benefits in promoting the circular economy and improving a manufacturer's sustainability profile. In particular, mono-materials structures can help eliminate the risk of contaminating the sortation stream, making recyclability easier to achieve.

At the same time, traditional mono-material packaging must be refined and improved if it is to perform with the same quality and safety functions as multi-material formats.

An important first step is to consider the product in line with its packaging options, including the benefits a flexible package can provide and if an alternative exists that can deliver a lower overall environmental impact while providing similar benefits. In some cases, certain products may be able to move away from single-use flexible packaging without unintended consequences, such as removing wraps and overwraps where not serving an essential purpose, by using edible coatings on vegetables/fruit, by using water soluble/dissolvable packaging, or through the use of a reusable package that functions in a reuse-refill system (e.g., where consumers are provided convenient return/refill options).

The task of converting multi-material structures to mono-material structures is not insignificant, as each layer of multi-material packaging has specific physical and mechanical properties that need to be met. For example, mechanical properties such as elasticity and stiffness, along with the sealability of the heat seal surface. It is also important to account for the role of coating on the sustainable packaging, as it will usually include printing or labeling. These coating resins can interfere with the recyclability of the mono-material packaging. Advancements in polymer sciences have helped to address the challenges of how to satisfy the performance criteria of the package (i.e., adhesion, printability, processability, yield, heat-sealability, transparency, and food contact compliance, etc.) of multi-material structures. See Appendix B: Key Design Elements of Flexible Packaging.

[3] See Appendix A: Polymers, Barriers, and Properties

Moving to Mono-material Packaging Structures (cont'd)

Consumers, brands, and retailers all desire their packaging to be more circular. Meeting this need with mono-material options may require major redesign if barrier and mechanical functionality is not to be compromised. Thanks to continued R&D developments we see these limitations being overcome, for instance, barrier layers are being substituted with thin coatings.

Processability must also be taken into consideration when developing new products. Hopefully existing packaging equipment can be utilized as replacing and/or modifying equipment can be very capital intensive.

PET, PVC, PVDC, paper, aluminum foil or degradable polymers are not accepted in polyolefin recycling streams and should be avoided in mono-material structures.

According to The Association of Plastics Recyclers' (APR) Design Guide, EVA co-polymers designed for film extrusion are included in the "preferred" category at any weight percent, provided the VA (vinyl acetate) levels are 5% or less of the total package weight. Non-PE layers or blend components at any level (%) require testing to determine the appropriate APR recyclability category. Also consider using APR's 'Critical Guidance Protocol,' which is a comprehensive laboratory scale evaluation that can be used to assess the compatibility of PE-based films and flexible packaging innovations with film reclamation systems.

APR is expected to release updated guidance on preferred levels of ethylene vinyl alcohol (EVOH) in packaging in the near future. We encourage readers to consult APR's latest resources for the most current guidance.

Factors to Consider: Moving to Mono-Material Flexible Packaging Structures

1. **Satisfy Packaging Performance Requirements**
   Barriers, resistance, strength, and appearance properties
2. **Satisfy Environmental Considerations**
   Shelf-life, food waste, and GHG emissions impacts, as well as end-of-life recyclability. Consider use of PCR whenever possible
3. **Compatible with Existing Packaging Machines (preferably)**
4. **Satisfy Packaging Effectiveness Considerations**
   Safety and compliance, logistics, consumer accessibility, convenience, choice and availability, labeling regulations/standards, branding requirements
5. **Stable Polymer Supply, Competitive Costs/Market Pricing**

Food versus Non-Food Considerations

When flexible packaging is the best option for your product, consider the following when looking to move to a mono-material package (based on if you have a food product or a non-food product).

Food Products

Mono-material flexible films are widely used in food packaging in both dry and frozen applications like bread bags and frozen vegetables, where PE or PP co-extruded and laminated structures perform well, as there are usually no barrier requirements.

Traditional packs like stand-up pouches and block bottom bags are also moving to all PE or PP materials where clever structure design and new materials have enabled the same end user experience and shelf appeal.

Gas Barriers/Modified Atmosphere Packaging (MAP)

Modified atmosphere packaging (MAP) is a packaging system that involves changing the gaseous atmosphere surrounding a food product inside a pack and employing packaging materials and formats with an appropriate level of gas barrier to maintain the changed atmosphere at an acceptable level for preservation of the food.

Moisture barrier mono-material packaging can be achieved with 100% PE packs using high-barrier grades available from certain producers, enabling moist or dry foods to retain suitable shelf life and freshness. Soups, drinks, crackers, and cereals, etc. can all be placed in these materials.

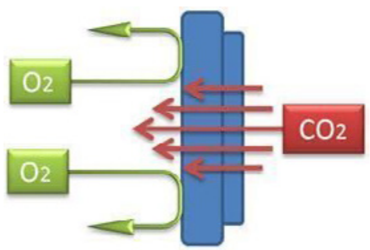
Modified atmosphere packaging (MAP) and high O2 barrier films (OTR < 1 cc/100 in^2/24 hrs.) made from mono material are not possible, so thin layers of barrier material must be included. If these layers are thin enough, and required compatibilizers are used, then these packs will be allowed into polyolefin recycle systems. This allows oxo degradable foods like nuts, jerky, or fatty snacks to remain fresh for a similar timespan as conventional films allow.

There are several gas barrier technologies that can be used successfully and allow recyclable structures, such as:[4]

- **Metallization coating** – Opaque, high barrier
- **SiOx or AlOx coating** – Clear high barrier
- **EVOH** – Co-extruded barrier layer that is clear (widely available technology)
- **Nanoclay coating** – Oriented PE films (relatively new technology)
- **PVOH coating** – Clear, moderate barrier layer

[4] See Appendix A: Polymers, Barriers, and Properties

Food versus Non-Food Considerations (cont'd)



Any food that is perishable by bacteria can have its shelf life extended by removal of air, and prevention of oxygen ingress, or retention of MAP gas such as nitrogen flushing (oxygen exclusion).

Typically, dense foods like fruit puree or cheese require vacuum packing or small headspace in its packaging to minimize the amount of air inside. To keep air out after packing, high-barrier films are used. Lower density packs like chips or saltines use nitrogen to remove air and provide crush resistance for its delicate contents.

Cold Supply Chain

Polyolefin PE and PP films have a low glass transition temperature (i.e., Tg) allowing them to remain ductile at low temperatures – deep frozen storage can be at –23 degrees Celsius or lower, so these films are useful for foods packed and kept in these conditions. The frozen condition negates the need for gas or moisture barrier, so simple structures can be specified.

Frozen vegetables like french fries and greens are commonly placed in mono-material bags, and also frozen meat portions and commodity-ready meals use these films.

Non-food Products

Non-food items such as medical/pharmaceutical, are more easily placed in mono-material flexible packaging if package design and payload size are optimized to ensure abuse resistance and product retention is accomplished.

Polyolefins (PE and PP) have good chemical resistance, so many household liquid chemicals and industrial products can be safely stored in them. Examples would be cleaning and soap dispenser refills, motor oils, personal care creams – some of which may need moisture or odour barrier from the technologies listed above. Dry, non-food items place lower demand on packaging, and usually aesthetics and abuse resistance are the primary concern.

Gas Barrier/Fragrance

Non-foods typically do not need a gas barrier, but quite often do need fragrance retention where the same barrier materials used for oxygen barrier will function for this requirement.

Typical flavour retention non-foods could be soap, toothpaste, cleaning chemicals, essential oils, garden products/materials, pungent chemicals like greases or lubricants.

Supply Chain

Non-food products do not typically have cold storage requirements, except for medicine products (which are not covered as part of this guidance document).

Other Considerations

Several other important considerations exist when moving from multi-material to mono-material flexible plastic packaging. These include specific performance considerations, manufacturing and production related considerations, and marketing and branding considerations – all of which are discussed in more detail in this section.

Performance Considerations

Retailers, brand owners, and manufacturers should consider the following aspects of a flexible package's performance when moving to mono-material:

- What is the primary functionality (e.g., pouch, resealable bag, a wrap, or film, etc.) and will mono-material allow for this or is an alternative option suitable?
- What barrier properties are important (including any modified atmospheric control), and can this be achieved through a mono-material PE or PP flexible plastic package?
- What convenience features are essential or important for the consumer and can they be included as a mono-material flexible package, such as:
  - Cooking options – microwave in bag, cook-in bag, retort
  - Hybrid packaging features such as spouts
  - Carrying handles
  - Zippers
  - Resealability to preserve freshness
- What are the transportation and logistical requirements, as well as shelf-life considerations and can they be met by a mono-material flexible package?
- What durability and/or abuse resistance is needed (e.g., drop test) and can mono-material satisfy these requirements?
- Are there any potential unintended consequences or increased environmental impacts (e.g., greater GHG emissions due to a shortened shelf-life) when moving to a mono-material versus multi-materials with added barrier layers?

Note that there continues to be many advances in technology and innovation for mono-material flexible packaging in areas such as biaxially oriented PE (BOPE), machine direction orientation (MDO), and others, allowing for improved performance of mono-material flexibles and, therefore, a much greater range of options.

Manufacturing and Production Considerations

Retailers, brand owners, and manufacturers should consider the potential impacts on manufacturing and production of flexible packaging when moving to mono-material, including:

Filling format considerations (i.e., pre-made format versus rollstock):

- Premade pouch packaging lines create packages at high speed and output using rollstock.
- Form-fill seal packaging lines (FFS) also use rollstock but have a lower speed and fill packages in line before sealing.
- The choice between the two systems involves cost benefits and considerations.
- Premade pouch equipment lines are more sophisticated and offer better control, making them more suitable for running mono-material films than form-fill seal equipment.

Product testing/certification considerations:

- Abuse resistance targets for each packed product must be determined and packaging designed to meet these tests (for example, drop testing and puncture testing).
- Field trials at customer sites.

Equipment and line settings and speeds:

- FFS lines using rollstock require careful adjustment to achieve strong hermetic seals and minimize material usage.
- Equipment designed to fill and seal pre-made pouches supplied from the convertor are easier to set and operate compared to rollstock lines.
- Depending on the material, line speeds may be affected by the heat resistance of the material in use.
- In the absence of abuse resistance layers in multi-material flexibles, a thicker material may be needed, and this may cause sealing issues on packaging lines that may require adjustments to settings or speeds.
- OEMs (packaging line manufacturers) are increasingly engaging in the development of equipment optimized for mono-material films

Overall cost for the flexible package on a per unit basis may be impacted when moving to mono-material based on several factors, such as raw material supplies, labour, production and line speeds, product testing and certification, freight, capital investments, and storage. Due to the variability of FFS roll stock packaging machines, there is a learning curve to perfect the settings. This may require more testing and create more downtime in production.

Marketing & Branding Considerations

Delivering your product in perfect condition is vital for creating both a positive brand experience and ensuring product quality. Retailers, brand owners, and manufacturers should consider the following aspects related to marketing and branding for a flexible plastic package when moving to mono-material, including **Look and Feel**, **Retail Shelf Considerations**, and **On-pack Labeling Considerations**.

Look and Feel

Questions about the flexible package's look and feel, including the user experience, are important to ask when moving to mono-material, such as:

- How is the package, as well as the brand and logo, presented to the potential consumer?
- How important is sustainability and the inclusion of recycled content to your brand and your consumers?
- Will lighting affect the product appearance at the retail level?
- Will the product be utilized at once or over multiple times?
- Is a resealable flexible package essential and/or important to the potential consumer?

Investigate the availability of features such as zipper, tamper seal, window, peg hole, vent hole, bottom gusset, side gusset, cook-in capability, and others. It may be possible to benchmark proposed solutions against a control. In addition, formats must be tested to ensure no adverse impact to feature through shipping and transportation.

Other Considerations (cont'd)

Retail Shelf Considerations

Questions about the flexible package's retail shelf impacts should be considered when moving to mono-material, such as:

- Where will the product be sold/merchandised and within which department (does the product need to be in retail-ready or retail-only packaging)?
- Is there a shelf-life to the product and will it require customized multi-layer films or specialized additives to maximize the life of the product before consumption?
- For food products, will it need to be refrigerated/frozen, or is it shelf stable?
- What kind of space is available for this product at the retail level?
- How many products can fit on the shelf?
- Does the product need to be upright on the shelf with a stand-up pouch format, or are there other formats that can support the product (e.g., display hooks, retail boxboard/corrugated cartons, etc.)?
- Will the product be retail specific, will it be shipped direct-to-consumer, or both?
- How are competitors presenting their products within a similar product category?

On-pack Labeling Considerations

Questions about the flexible package's on-pack labeling should be considered when moving to mono-material, such as:

- Can the mono-material format work in accordance with company branding requirements?
- Based on branding and what information needs to be conveyed to consumers, can the mono-material format provide the appropriate amount of advertising space?
- Can the mono-material format comply with labeling regulations and standards, including recycling instructions (e.g., How2Recycle or similar program if applicable)?

CANADA PLASTICS PACT

Take Action

The Pathways to Mono-Material Guide is intended to provide valuable guidance for stakeholders in the plastics packaging value chain who want to improve the recyclability of flexible plastic packaging and films in Canada.

We encourage readers to identify areas where they can apply the guidance to their operations to make a meaningful contribution to advancing the circularity of flexible plastics and reducing waste and pollution.

Join our collective efforts to advance a circular economy for plastics packaging in Canada.

Contact us at info@plasticspact.ca

About the Canada Plastics Pact

The Canada Plastics Pact (CPP) is tackling plastic waste and pollution, as a multi-stakeholder, industry-led, cross-value chain collaboration platform. The CPP brings together Partners who are united behind a vision of creating a circular economy in Canada in which plastic waste is kept in the economy and out of the environment. It unites businesses, government, non-governmental organizations, and other key actors in the local plastics value chain behind clear actionable targets for 2025. The Canada Plastics Pact is a member of the Ellen MacArthur Foundation's Global Plastics Pact network. It operates as an independent initiative of The Natural Step Canada, a national charity with over 25 years' experience advancing science, innovation and strategic leadership aimed at fostering a strong and inclusive economy that thrives within nature's limits.

Learn more about the CPP

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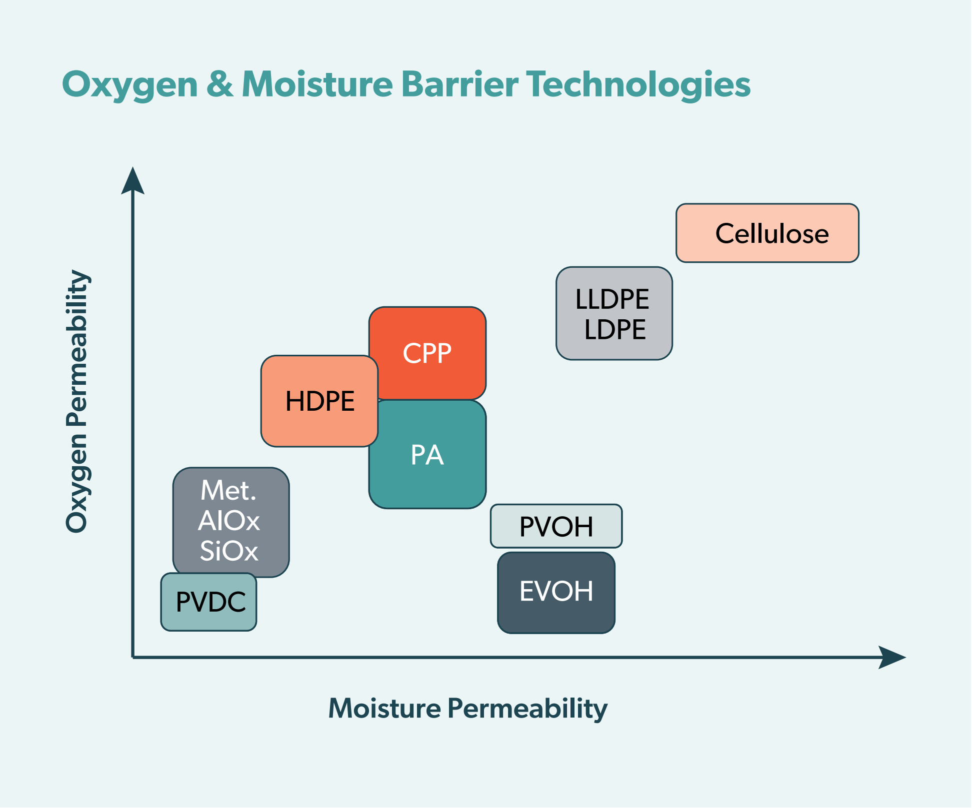
Appendix A: **Polymers, Barriers & Properties**

The most common polymers/materials utilized in the flexible packaging industry are PE, PP, and PET, EVOH, Nylon (PA), ionomers (EAA, EMAA), and EVA. Others include PVDC, SiOx, and AlOx. Among these, PE is typically the most predominate polymer as it is easy to process and can be combined with gas/aroma barriers such as PA and EVOH.

The most applicable grade is LLDPE, as it is a high-clarity heat-sealable material widely used for food packaging. LLDPE is sometimes combined in multi-layer films with HDPE which is stiffer, harder, and has higher tensile and bursting strength, but lower impact and tear strength than LLDPE. The combination of LLDPE and HDPE provides superior properties and allows for thinner films. For this reason, most of today's packaging films include more than one olefin layer.

For example, cereal bags consist of several layers of HDPE, LDPE and LLDPE combined with an aroma barrier, whereas films that require higher mechanical strength and/or improved heat resistance (microwavable and hot-filled food packaging) are commonly made from PP. With its superior heat resistance, PP provides the basic strength of the packaging and contributes to the moisture barrier.

Some important limitations of PE films are poor gas barrier properties, low temperature resistance, and difficult to bond. To improve these properties, polyolefins are often combined with polar polymers such as PA, EVOH or PVDC. However, coextrusion of these materials requires tie layers because non-polar olefins do not adhere well to these polymers.



Common Polymers

Polyolefins – refers to PE and PP, the most widely used plastics in food packaging. PE and PP both possess a successful combination of properties, including flexibility, strength, lightness, stability, moisture, and chemical resistance, and easy processability, and are well suited for recycling (as separate streams).

HDPE (High Density PE) is stiff, strong, tough, resistant to chemicals and can have excellent moisture barrier, be easy to process, heat resistant, and easy to form. HDPE has a higher melting point which makes it suitable for high temperature applications. Commonly used to make rigid bottles, but also used in cereal box liners, grocery, trash, and retail bags.

LDPE (Low Density PE) is flexible, strong, tough, soft, and easy to seal. Because LDPE is relatively transparent, it is predominately used in film applications and in applications where heat sealing is necessary. Used in bread and frozen food bags, garbage bags, stretch and shrink films, and flexible lids.

LLDPE (Linear Low-Density PE) generally has superior properties to LDPE, such as higher physical strength, and higher temperature tolerance. Higher tear, tensile and impact strength, all allowing a stronger material to be produced with less material. Typically used for carrier bags, stretch films, pond liners, and heavy-duty shipping sacking (pet food bags).

BOPE (Biaxially Oriented PE) film is made of HDPE and LLDPE resins and is a high-performance film material that provides good heat seal strength, high puncture and wear resistance, high tensile and impact strength, low temperature flexibility and resistance to pinholes, high stiffness, and transparency. It is relatively easy to tear and reduces package substrate thickness approximately by 50%. BOPE is compatible with PE in recycling systems.

MDO-PE (Machine Direction Orientation Polyethylene) films are HDPE-rich films stretched in the process to make them clear, thin, and stiff, and can be used to reduce packaging costs through film downgauging and process consolidation. They are used to manufacture mono-polymer packaging (PE) thereby making them recyclable.

PP (Polypropylene) has better temperature resistance than PE and has good resistance to chemicals and is effective at barring some water vapor. It's good for use in hot-fill, microwaveable, and retort packaging. RecyClass identifies PP 'limited compatibility' with PE in recycling if PP is < 5%.

CPP (Cast PP) is an un-oriented film that is very useful for certain applications, including high-temperature uses such as retort sterilization, boil-in-bag, or microwave cooking—situations where PE is not suitable. CPP also offers good sealing performance, making it valuable in high-clarity packs, thermoformable films, and medium moisture barrier applications. However, it typically costs more than PE, which limits its use in standard applications where PE is used.

OPP (Oriented PP) provides bags with high tensile strength and transparent colours. They can withstand high temperatures, but are brittle compared to non-oriented PP. It can be used as a less expensive, lower performance alternative to PET.

PET (Polyethylene terephthalate) is not compatible with a PE, PP, or mixed polyolefin mechanical recycling process due to its significantly higher melt temperature (E.g., 250°C versus 135°C for HDPE). If PET is laminated to a PE, PP, or mixed PO then this combination will be non-recyclable.

EVA (ethylene vinyl acetate) provides heat seal, impact strength, and adhesion properties. EVA is compatible with recycling because it is a PE copolymer.

Barrier Layers and Coatings

Barrier layers and coatings provide important packaging functionality. The choice of barrier material and coating, and the amount used, will have an impact on the sortability and recyclability of packaging. In order to take account of the product protection and functionality requirements, the use of barrier materials and coatings will still be required in certain applications. Where possible, the use of these should stay within the limits given for their recyclability (e.g., maximum of 5% is preferable, allowed up to 10% – see GDR 6) or tested using APR test protocols for compatibility. The use of the following barrier layers and coatings for polyolefin-based structures is permitted within specific limits.

Nylon (Polyamide) provides oxygen, aroma, and grease barrier properties as well as excellent general mechanical and puncture resistant properties, boil-in bag capabilities, plus good chemical resistance, toughness, and moderate gas permeability. Nylon coating is compatible with PE for recycling if it is < 5%. To ensure optimal outcomes, it is essential to use a compatibilizer.

EVOH (ethylene vinyl alcohol) is a co-extruded layer often used in multi-layer polyolefin-based structures as a coating to give a gas, oil, fat, and oxygen barrier (e.g., used in coffee, cheese, meat packaging). Small amounts of EVOH in the total PE packaging structure is permitted. Larger quantities are thought to result in issues during reprocessing and impact the quality of the recyclate.

SiOx (silicon oxide), **AlOx** (aluminum oxide), and **metalized aluminum** are applied as very thin layer coatings to give excellent gas and moisture barrier properties. SiOx and AlOx coatings are compatible with PE recycling at minimum levels.

Metalized PE is an aluminum-coated polyethylene with exceptional barrier performance. It is designed for use in all PE packaging structures, making it an ideal choice for a recycle-ready packaging solution. However, metalized film structures can create issues during recycling/reprocessing by triggering metal detector alarms during sortation. As such, APR Guidelines require testing.

PVDC (polyvinylidene chloride) is heat sealable and serves as an excellent barrier to water vapor, gases, and fatty and oily products. It is used in flexible packaging as a barrier coating used commonly in food applications including fresh meats and poultry, cheese, snack foods, tea, coffee, and confectionary. It is also used in hot filling, retorting, low-temperature storage, and modified atmosphere packaging. PVDC is considered a contaminant with polyolefins within a recycling operation.

Appendix A: **Polymers, Barriers & Properties** (cont'd)

- Compatible with PO for recycling
- May require testing for approval
- Not compatible with PO for recycling

- **L** Low performance
- **M** Medium performance
- **H** High performance

Key Polymers & Barriers: Common Properties & Compatibility with PO Structures*

Polymers	Barriers						Resistances		Appearance		Strength			Other		
	Gas	O2	Fat	Aroma	Grease	MVTR	Chemical**	Thermal	Clarity	Glossy	Tear	Tensile	Burst	Adhesion	Stiff	Heat Seal
LDPE	–	–	–	–	–	–	M	–	H	H	L	–	–	M	–	H
LLDPE	–	–	–	–	–	–	M	–	H	H	M	–	L	M	–	H
HDPE	L	–	–	–	M	M	H	L	L	L	M	L	L	M	M	M
OPP	L	–	–	–	–	–	H	L	H	H	H	L	–	L	M	L
CPP	–	–	–	–	–	L	H	L	L	M	M	–	L	L	L	M/H
EVOH	M	M	M	M	M	–	L	L	H	H	–	–	–	L	L	–
PVDC	M	M	M	M		M	H		L	H	–	–	–	L	–	M
Nylon (PA)	L	L	–	L	–	–	H	M	H	H	H	L	H	M	M	–
PET	–	–	–	–	M	–	H	M	H	H	–	M	M	M	M	–
Ionomers (EAA, EMAA)	–	–	H	H	–	–	M	–	H	H	–	–	–	M	–	H
EVA	L	–	H	–	H	L	M	–	H	H	–	–	–	M	–	H
SiOx PET/OPP	M	M	–	–	M	M	L	M	H	H	–	M	–	L	M	–
AlOx PET/OPP	M	M	–	–	M	M	L	M	H	H	–	M	–	L	M	–
Metallized PET/OPP	M	M	–	–	M	M	L	M	–	H	–	M	M	L	–	–
Aluminum Foil	H	H	H	H	H	H	L	H	–	H	–	H	–	L	H	–

*Observed properties of multilayer films may differ from the above.
**It should be noted that certain chemicals can adversely affect different polymers. This is intended as a general guide only.

Appendix A: **Polymers, Barriers & Properties** (cont'd)

L Low performance
M Medium performance
H High performance

Flexible Material Cheat Sheet

Material	Stiffness	Toughness	Freezer safe	Recyclable	Printability	Barrier WVTR	Barrier OTR	Sealing	Clarity	Cost	Comments
OPP	L	–	–	H	L	–	–	M	H	H	Not widely recycled in NA, but under investigation in some Canadian provinces
OPP/OPP	M	L	–	H	H	–	–	M	M	M	Not widely recycled in NA, but under investigation in some Canadian provinces
PE Coex	L	M	H	H	L	M	–	H	M	H	Recyclable without compatiblizer
PE/PE laminate	M	H	H	H	H	M	–	H	M	M	Recyclable without compatiblizer
MDO PE/PE laminate	H	M	H	H	H	L	–	H	M	M	Recyclable without compatiblizer
BOPE PE/PE laminate	H	M	H	H	H	L	–	H	M	M	Recyclable without compatiblizer
PET/PE	H	M	M	–	H	–	–	H	H	M	Not recyclable
OPA/PE	M	H	H	–	M	–	L	H	M	L	Possibly recyclable pending testing
OPP/PE	M	M	M	–	H	–	–	H	H	M	Possibly recyclable pending testing
OPP-MetOPP	M	L		–	H	M	H	M	–	M	Possibly recyclable pending testing
OPP/MetPET/PE	H	H	M	–	H	H	H	H	–	L	Not recyclable
PET/MetPET/PE	H	H	M	–	H	H	H	H	–	L	Not recyclable
PE/PE EVOH-PE	H	H	H	L	M	M	H	H	M	L	Recyclable with compatiblizer
OPE Barrier coated/ PE	H	M	H	H	H	L	H	H	M	L	Recyclable without compatiblizer
OPE/Met OPE/PE	H	H	H	H	H	L	M	H	–	L	Recyclable without compatiblizer

Source: Nova Chemicals

Appendix B: **Key Design Elements of Flexible Packaging**

Consider the following design elements as you move from a multi-material flexible plastic packaging structure to a mono-material structure. Some additional resources are provided for your use.

Packaging Performance Requirements

What product will be in the package? What performance specifications is the packaging to provide?

- **Strength** – Tear, Impact, Tensile, Compression, Burst, Seal
- **Barrier** – Gas, Oxygen, Oil, Fat, Aroma, Grease, Moisture Vapour
- **Resistance** – Thermal, Heat-seal, Chemical, Moisture
- **Appearance** – Clarity, Glossy, Printable
- **Other** – Adhesion, Stiffness, Resealable

Barriers

Minimize the use of barrier materials, whenever possible, to reduce the risk of contamination, and lessen the need for compatibilizers. See 'Polymers, Barriers & Properties' in Appendix A.

Adhesives/Tie-Layers

Minimize the use of adhesives and tie-layers whenever possible. This will help facilitate higher quality and quantity of mechanical recyclate.

Note – Barrier materials help to extend product shelf-life and should not be replaced or removed if it could cause negative impact on the protection of the packed product, as there is greater environmental impact of product waste than packaging waste. Also see link to RecyClass natural and coloured PE & PP films compatibility requirements in Appendix D: Additional Information & Resources.

Pigments/Inks/Lacquers

Clear, natural, paler colours are preferred, as dark colours cause plastic to become greyer over time, and carbon black is not typically recognized by optical scanners at MRFs. Printing should be minimized, as it can impact colour and pellet quality similarly to pigmentation. PVC is not allowed, including in wet chemical recycling processes. Lacquers must not contain PVC, and surface printing is preferred over embedded or full-coverage printing.

Additives & Fillers

Allowed but should be minimized and must film float during recycling. These include thermal stabilizers, UV stabilizers, anti-stats, chemical blowing agents, etc.

Size/Weight/Shape

The minimum viable amount of material should be used to minimize package size and weight.

Density

A density of plastic-based structures below 1g/cm³ is encouraged to ensure that polyolefin materials float during recycling and can be effectively separated from non-polyolefins. Additives must not increase the density above this threshold and should be selected to maintain floatability in water-based separation processes.

Labels

Should ideally be the same material as the main packaging i.e., mono-PE or mono-PP, and should comply with Canadian labeling regulations and standards. See the following links for more details.

a. **Canada Packaging and Labelling Requirements**
https://ised-isde.canada.ca/site/competition-bureau-canada/en/labelling/prepackaged-non-food-consumer-products/packaging-and-labelling-requirements

b. **Guide to the Consumer Packaging and Labelling Act and Regulations**
https://ised-isde.canada.ca/site/competition-bureau-canada/en/how-we-foster-competition/education-and-outreach/publications/guide-consumer-packaging-and-labelling-act-and-regulations

c. **Consumer Packaging and Labelling Regulations (C.R.C., c. 417)**
https://lois-laws.justice.gc.ca/eng/regulations/C.R.C.,_c._417/

d. **Labelling Requirements**
https://www.canada.ca/en/services/business/permits/federallyregulatedbusinessactivities/labellingrequirements.html

e. **Top Five Canadian Labelling Must-Haves**
https://www.canadianpackaging.com/features/top-four-canadian-labelling-requirements/

Other Package Components

It is suggested that zippers, spouts, closures, fitments, valves, and taps should be made of the same material as the main packaging i.e., mono-PE or mono-PP.

Recycled Content

Is encouraged, but you need to ensure food contact and indirect food contact packages adhere to local food safety regulations.

Other Considerations

a. **Canadian Golden Design Rules**
Especially Rule #6 for flexibles should be applied, namely, HDPE/LDPE non-laminated films and bags are preferred wherever possible for packaging design choices. In the Canadian market, design choices should strongly prioritize the use of polyethylene (PE) in packaging materials or polypropylene (PP). Ideally, the packaging should contain at least 90% mono PE or PP. If barriers or additives are necessary, they should be used in accordance with the APR Design Guide for PE films. For more details, please refer to Section 4 GDRs on Page 2.

b. **Food/Non-Food Applications**
If food application, consider evaluating any available existing LCA data for the package. If no LCA data exists, consider conducting full or streamlined LCA to determine the environmental impact of the

new mono-material package (i.e., food waste, GHG emissions). This will allow you to compare the new package's impact to that of the current multi-material structure. Even though a mono-material structure is better designed for recycling, it may not be the most sustainable packaging option across the full life cycle, as it may create unintended consequences such as increasing food waste and therefore increasing GHG emissions. If non-food application, LCA is not as important.

c. Plastic Recycling & Infrastructure Challenges

Even if all multi-material flexible plastic packaging structures could be converted to mono-materials, there remains collection, sortation, and recycling infrastructure and education challenges that need to be addressed. Therefore, the ultimate success of converting to mono-materials will depend on the support and development of the post-use collection, sorting, and recycling systems, as well as clear communication of recyclability from manufacturers to consumers.

In the meantime, even though the proposed mono-material structure may not be recyclable today, don't let the lack of current collection, sortation, recycling infrastructure and/or end markets deter you from converting from multi-material structures now. If you design the mono- structure with compatible polymers to polyolefins (E.g., PE with EVOH), you are increasing the likelihood of recycling, and once critical scale is achieved the infrastructure will follow.

d. Safety, Quality & Compliance

Consider whether the proposed mono-material structure meets safety, quality, and food-contact compliance standards. Review IFS PACsecure, 'Standard for Assessing Product and Process Compliance in Relation to the Safety & Quality of Packaging Material' for more details.

e. Logistics

Consider logistical needs of proposed mono-material structure, such as cold storage, transportation, and polymer storage (warehouse and/or silo) needs.

f. Cost & Return on Investment (ROI)

Consider total net costs (& resulting ROI) related to the proposed mono-material structure and ensure acceptable as per your company's internal requirements. Consider all costs, such as new raw materials, labour, production (i.e., pre-form versus roll stock), freight, capital investments for modified/new equipment & storage silos, marketing/promotions, EPR fees, etc., net of any savings). See the following link for more details: Understanding the Cost of Packaging.

g. Consumer/Product Choice, Accessibility, Availability and Convenience

Determine how the mono-material structure impacts product availability and accessibility, and consumer choice and convenience. When evaluating consumer accessibility and convenience, determine the reasons packaging can cause consumer difficulties in the first place. Things to consider include such as ease to open, single serve, resealable, portions control, tear-off perforations, portability, one-handed use, clear and easy-to-read labeling, and a pleasing look-and-feel in your evaluation versus incumbent packaging. Consider not only able-bodied users, but also individuals with disabilities who may face challenges with the packaging due to issues related to dexterity or visual impairment. Research by Arthritis Australia shows that when experiencing hard to open packaging – 21% look to buy a competitor's product, and 56% look for the same product but in a different packaging format.

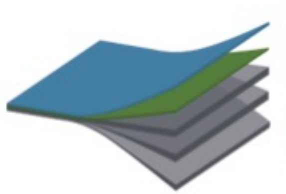
See the following links for more details:

- **Food Packaging Design Accessibility Guidelines**
  https://arthritisaustralia.com.au/wordpress/wp-content/uploads/2018/01/Food-Packaging-Design-Accessibility-Guidelines_Arthritis-Australia.pdf
- **Six Things to Consider When Packaging for Convenience**
  https://lekac.com/general/6-things-to-consider-when-packaging-for-convenience
- **Convenience Drives Food Packaging Innovation**
  https://www.foodprocessing.com/home/article/11330969/convenience-drives-food-packaging-innovation
- **How Does Packaging Affect Consumer Behavior**
  https://www.meyers.com/meyers-blog/how-does-packaging-affect-consumer-behavior/
- **Why Does Food Packaging Influence Consumer Behavior**
  https://thegreatergoods.ca/food-packaging-influences/

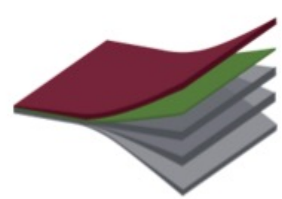
Appendix C: **Examples of Mono-Material Plastic Packaging Structures**

Laminated Films for Non-Barrier Packages

This example shows how a PET-PE non-barrier structure, common for dry, non-perishable foods, such as flour or rice, or non-food items like detergents or hardware items, can be converted to a recyclable mono-material structure by displacing the PET with either a biaxially oriented PE (BOPE) or machine direction-oriented PE (MDO-PE). The mono-structure, including the addition of a HDPE layer in the sealant film, will provide similar performance as the multi-material structure with the advantage of now being a recycle-ready material acceptable for store drop-off with no testing requirements.



12 µm PET
Adhesive
40 µm LLDPE
41 µm LLDPE
31 µm LLDPE

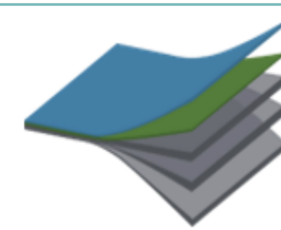


25 µm BOPE-HD or
25 µm MDO-HD
PE Adhesive
40 µm LLDPE
30-40 µm HDPE
25-30 VLDPE

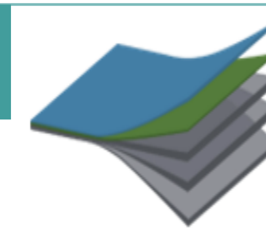
µm = micrometer   1 µm = 1 millionth of a meter

Laminated Films for Barrier Packages – Testing Required

This example shows how a PET-PE-EVOH-PE non-recyclable barrier structure (stand up pouch, pillow pack vertical form, fill, seal (VFFS), lidding film for trays or thermoformed packs, or flow wrap pouches), common for products such as meat and cheese which need oxygen barrier, may be converted to a recyclable mono-material PE+PE-EVOH-PE structure. By replacing the PET with either a blown or oriented PE print web, and adding a compatibilizer, this material can now be accepted in a How2Recycle type store drop-off collection program for recycling where available in North America (testing will need to be completed at an APR accredited lab first).



12 µm PET
Adhesive
20 µm LLDPE
20 µm MDPE
10 µm LLDPE+Tie
4-7 µm EVOH
10 µm LLDPE+Tie
20 µm HDPE
15-25 VLDPE



25 µm Blown or
oriented PE print web
Adhesive
20 µm LLDPE
20 µm MDPE
10 µm LLDPE+Tie
4-7 µm EVOH
10 µm LLDPE+Tie
20 µm HDPE
15-25 VLDPE

Appendix D: **Additional Information & Resources**

1. Andrea Dorigato, 'Recycling of Polymer Blends,' April 2021, https://www.sciencedirect.com/science/article/pii/S2542504821000130
2. Brand Packaging: Why It Matters & How to Nail It, https://looka.com/blog/branded-packaging/
3. CEFLEX 'Designing for a Circular Economy – Recyclability of Polyolefin-based Flexible Packaging,' June 2020 https://guidelines.ceflex.eu/
4. CPMA 'Packaging Material Selection Guide,' https://cpma.ca/docs/default-source/industry/2020/CPMA_Packaging_Materials_Selection_Guide.pdf
5. CPP Golden Design Rules, https://goldendesignrules.plasticspact.ca/
6. Materials Recovery for the Future Project https://www.materialsrecoveryforthefuture.com/
7. Nicolas Mazzola & Clare Sarantopoulos, 'Packaging Design Alternatives for Meat Packaging,' https://www.intechopen.com/chapters/68737
8. RecyClass 'Design for Recycling Guidelines; for Natural and Colored PE & PP films,' https://recyclass.eu/recyclability/design-for-recycling-guidelines/
9. Select LCA Tools/Providers
   a. Quantis, https://quantis.com
   b. CIRAIG, https://ciraig.org/index.php/about/
   c. Franklin Associates, https://fal.com
10. PP Design Guide: https://plasticsrecycling.org/apr-design-hub/apr-design-guide/pp-flexible-guidance/
11. Sortation Protocol: https://plasticsrecycling.org/wp-content/uploads/2024/07/SORT-S-03-Metal-1.pdf
12. Resource Document for metal specific definitions: https://plasticsrecycling.org/wp-content/uploads/2024/07/RES-SORT-03b-Metal-Decoration-Resource.pdf
13. Recognition Directory: https://plasticsrecycling.org/apr-design-hub/apr-design-recognitions-directory/
14. Design Guide Overview: https://plasticsrecycling.org/apr-design-hub/apr-design-guide-overview/